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Control system for a vehicle

The present invention relates to a control system for a vehicle, in particular for a combination of a towing vehicle and trailer, having the features of the preamble of claim 1.

DE 100 32 179 A1 has disclosed such a vehicle control system in which the vehicle is equipped with an electronically actuable drive train which comprises at least one steering system, a brake system and a drive assembly. An operator control device which is permanently installed in the vehicle defines here an input level via which a vehicle driver can input a driver request and which generates a standardized movement vector from the driver request. A control device defines a coordination level which generates control signals at the output end from the input-end movement vector in order to actuate the drive train. In order to transmit the control signals, the control device is coupled to the drive train, which then processes the control signals in order to implement the driver request. The known control system is characterized by a high level of variability since input levels which are configured in different ways and coordination levels which are configured in different ways can particularly easily be combined with one another provided that the driver request is always converted into the control signals by means of the standardized movement vectors.

In utility vehicles, for example trucks, a person to give directions is necessary for maneuvering, preferably for backward travel, in order to reduce a

risk of collision between the vehicle and an obstacle. Furthermore, the maneuvering, and especially the backward travel, in the case of a combination of a towing vehicle and trailer is particularly difficult owing to the given kinematic coupling.

The requirement of a person to give directions is extremely disruptive in the case of a truck from the economic point of view since when the truck is in operation it mainly fulfills a transportation function in which there is no need for a person to give directions, and compared to this maneuvering has to be carried out only for a very short part of its operating time. There is therefore the desire to eliminate the person to give directions.

The present invention is concerned with the problem of specifying, for a control system of the type mentioned at the beginning, an improved embodiment which in particular simplifies the maneuvering of the vehicle.

This problem is solved according to the invention by means of the subject matter of the independent claim. Advantageous embodiments are the subject matter of the dependent claims.

The invention is based on the general idea of using a path computer to calculate a movement path which makes available a sequence of movement vectors which, when they are processed, move the vehicle from a starting position to a destination position. The starting position can be defined here by actual values for the orientation and position of the vehicle, which values can be determined using a suitable orientation- and position-determining device. For the destination position, setpoint values for the orientation and position of the vehicle are used which can be predefined using a destination-inputting device. It is

of particular significance here that the path computer transmits the acquired movement vectors via a drive train interface to the control device via which the operator control device which is fixed to the vehicle also transmits the movement vectors to the control device. During the calculation of the movement path, the path computer can take into account the kinematic and dynamic properties of the vehicle. This is achieved by the vehicle being guided along an optimum, in particular risk-free movement path. The maneuvering of the vehicle can be automated by predefining the setpoint values and by monitoring the actual values and can be considerably simplified for the driver. In particular, a person to give directions can be dispensed with.

In one advantageous development, the path computer is designed to calculate such a movement path in which the vehicle is traveling backward or which contains at least one movement path section in which the vehicle travels backward. This embodiment has a particularly advantageous effect if the vehicle is a combination of a towing vehicle and a trailer since the backward travel of a combination is extremely difficult and time-consuming even for experienced drivers. By calculating the backward travel and processing the movement vectors which are necessary for this it is possible for the vehicle generally to reach the desired destination position at the first attempt with the control system according to the invention.

Further important features and advantages of the invention emerge from the subclaims, from the drawings and from the associated description of the figures with reference to the drawings.

It goes without saying that the features which are specified above and the features which are still to be

explained below can be used not only in the respectively specified combination but also in other combinations or alone, without departing from the scope of the present invention.

Preferred exemplary embodiments of the invention are illustrated in the drawings and will be explained in more detail in the following description, identical reference symbols relating to identical or functionally identical or similar components.

In the drawings, in each case in schematic views:

Fig. 1 is a highly simplified basic outline, in the manner of a circuit diagram, of a control system according to the invention,

Fig. 2 is a plan view of a combination as a basic illustration,

Fig. 3 is a plan view, as in fig. 2, but with another combination, and

Fig. 4 is a plan view of a combination as in fig. 2, but with sections of the travel path of the vehicle.

According to fig. 1, a control system 1 according to the invention comprises a drive train 2 of a vehicle 3 which is shown in figs 2 to 4. The control system 1 operates here with an electronically actuable drive train 2, and can therefore also be referred to as a drive-by-wire system or X-by-wire system. The drive train 2 comprises here a drive assembly 4, a transmission 5, a steering system 6, a brake system 7 and a ride level control device 8. It is apparent that in another embodiment, the drive train 2 can also have more or fewer components 4 to 8. In an electronically

actuable drive train 2 there is no continuous mechanical or hydraulic connection between the individual components 4 to 8 of the drive train 2 and operator control elements 9, which are generally arranged in a cockpit of the vehicle 3. The operator control elements 9, which together form an operator control device 10 of the control system 1, are, for example, an accelerator pedal 9_4, a gearspeed-shifting device 9_5, a steering wheel 9_6, a brake pedal 9_7 and a controlling element 9_8 for the ride level control 8 of the motor vehicle 3.

By means of the operator control elements 9 it is possible for a vehicle driver to input a driver request FW into the operator control device 10. The operator control device 10 then generates a movement vector BV from the input-side driver request FW, and it transmits said movement vector BV at the output end to a drive train interface 11. The drive train interface 11 passes on the movement vector BV to a control device 12. Since the vector is a standardized movement vector BV, the control device 12 can generate control signals SS from the movement vector BV and transmit these control signals SS to the drive train 2 in a suitable manner. The drive train 2 can then process the incoming control signals SS, as a result of which the driver request FW is implemented.

With respect to the transmission of signals between the control device 12 and drive train 2 or its components 4 to 8, reference is made otherwise to the abovementioned DE 100 32 179 A1, whose contents are herewith incorporated by express reference in the disclosed contents of the present invention.

The control system 1 according to the invention also comprises a path computer 13, which is also connected to the drive train interface 11 and which communicates

with an orientation- and position-determining device 14 and with a destination-inputting device 15.

Actual values for the orientation and position of the vehicle 3 can be continuously determined using the orientation- and position-determining device 14. "Position" is understood here to be the geographic location of the vehicle 3, while "orientation" is understood to be the orientation of a longitudinal direction of the vehicle 3 with respect to a geographic coordinate system, preferably with respect to the cardinal points. These actual values are transmitted by the orientation- and position-determining device 14 to the path computer 13.

Setpoint values for the orientation and position of the vehicle 3 can be input into the destination-inputting device 15, and this can be done, for example, manually or in an automated fashion. These setpoint values, that is to say the setpoint orientation and the setpoint position, define here a destination orientation and destination position which the vehicle 3 is to assume at the end of its movement. For example, the vehicle 3 which is embodied as a truck is to be driven up to a loading ramp in such a way that the loading and unloading of the vehicle 3 can be started immediately. The destination-inputting device 15 is coupled to the path computer 13 in order to transmit the setpoint values.

The path computer 13 is then configured in such a way that it calculates a movement path from the incoming actual values and the incoming setpoint values, this movement path being formed by a sequence of standardized movement vectors BV. The movement path is calculated here in such a way that it moves the vehicle 3 from the actual orientation and the actual position into the setpoint orientation and the setpoint position

when the drive train 2 processes the movement vectors BV of the movement path. Since the path computer 13 is coupled according to the invention to the control device 12 via the drive train interface 11, the control device 12 can convert the movement vectors BV generated by the path computer 13 into control signals SS in accordance with the movement path and said control signals SS are processed by the drive train 2 exactly as if the movement vectors BV came from the operator control device 10.

Owing to the design of the control system 1, the path computer 13 can particularly easily be integrated into the control system 1 without increased expenditure being necessary for this purpose.

During the calculation of the movement path, the path computer 13 can take into account vehicle ambient conditions such as, for example, a course of the road in the region of the vehicle 3 and/or a minimum distance of the vehicle 3 from obstacles. In order to be able to convey the vehicle ambient conditions to the path computer 13, an input device 16 can be provided into which the vehicle ambient conditions can be input. In one expedient embodiment, this input device 16 can already be integrated into the destination-inputting device 15. The input devices 15, 16 may be, for example, a keyboard and/or a corresponding reader device. Furthermore, it is possible to provide a sensor system 17 which is configured in such a way that it senses conditions which are predefined in the surroundings of the vehicle 3, such as, for example, the edge of the road and distance values, and transmits them to the path computer 13.

The orientation- and position-determining device 14 is expediently configured in such a way that it continuously acquires the actual values of the vehicle

3. For example, the actual values of the orientation and position change as the movement vectors BV of the calculated movement path are processed. The path computer 13 is expediently configured in such a way that it continuously updates and recalculates the movement path by means of the new, current actual values. In this procedure it is sufficient to determine the movement path only relatively roughly at the beginning and only define it more precisely as the destination is approached. By continuously updating the movement path it is also possible to take into account vehicle ambient conditions which additionally come about, or change, during the movement of the vehicle 3.

Fig. 1 shows a further, specific embodiment in which the control system 1 comprises a transceiver arrangement 18, which is indicated by a brace. This arrangement 18 has at least one transmitter 19 and at least one receiver 20.

The path computer 13 and the components 14 to 17 which are connected thereto are expediently permanently installed on the vehicle 3. However, in addition or alternatively it is possible to provide an embodiment in which the path computer 13' is arranged, together with its peripherals 14' to 17', at a distance from the vehicle 3. This remote path computer 13' is connected to the transmitter 19 and transmits the movement vectors BV of the movement path to it. The transmitter 19 generates, from the movement vectors BV, remote control signals FS which are received by the receiver 20. The receiver 20 can regenerate the movement vectors BV again from these remote control signals FS and transmit said movement vectors to the control device 12 via the drive train interface 11. The path computer 13' which can be moved to a remote position and the path computer 13 which is fixed to the vehicle can be used as alternatives or in combination. Furthermore it is

apparent that a different configuration of components which are fixed to the vehicle and components which can be moved to a remote position is possible. For example, the path computer 13 can be fixed to a vehicle, while one or more of its peripheral components 14 to 17 are arranged remotely from the vehicle 3 and communicate with the path computer 13 via a suitable transceiver arrangement.

According to fig. 2, the control system 1 according to the invention is particularly suitable for a vehicle 3 which is embodied as a combination vehicle and which accordingly has a towing vehicle 21 and a trailer 22. The embodiment according to fig. 2 is concerned with a combination vehicle 3, in which the trailer 22 is coupled to the towing vehicle 21 via a towbar 23. As an alternative to this, fig. 3 shows another combination vehicle 3 in which the trailer 22 is embodied as a semitrailer which is thus coupled to the towing engine or towing vehicle 21 without a towbar.

Insofar as the orientation- and position-determining device 14 is a device which is fixed to the vehicle, the vehicle 3 can be equipped with a satellite navigation receiver 24 in accordance with figs 2 and 3. Furthermore, both the towing vehicle 21 and the trailer 22 are each equipped with an electronically readable compass 25 or 26. In the combination vehicle 3 which operates with the towbar 23, a bend angle sensor 27 is also provided and said sensor 27 determines the bend angle between the towbar 23 and trailer 22. In addition or alternatively, it is also possible to provide a bend angle sensor which acquires the bend angle between the towbar 23 and the towing vehicle 21. For more details on the method of operation and the structure of the orientation- and position-determining device 14 which is fixed to the vehicle it is possible to refer to DE 100 31 244 A1, whose content is herewith added to

the disclosed content of the present invention by express reference.

Alternatively, the orientation- and position-determining device 14 may also be a device which is remote from the vehicle 3 and which operates, for example, as a radar system.

Insofar as the vehicle is a combination vehicle 3, the orientation- and position-determining device 14 is constructed in such a way that it can be used to determine the actual values for the orientation and position both of the towing vehicle 21 and of the trailer 22. Furthermore, the destination-inputting device 15 is then configured in such a way that the setpoint values for the orientation and position of the towing vehicle 21 and/or of the trailer 22 can be input.

With reference to fig. 4, a description will now be given of a specific application case for which the control system 1 according to the invention is particularly suitable.

Fig. 4 shows a detail of a site 28 of a loading station, in particular of a freight yard. On this site 28 there is at least one loading ramp 29 which has to be approached by a combination vehicle 3, for example, in such a way that the rear end 30 of the trailer 22 is positioned approximately in front of the loading ramp 29. However, only a relatively small holding bay 31, into which the trailer 22 must be driven backward, is located in front of the loading ramp 29.

The optimum destination position of the trailer 22 in the holding bay 31 on the ramp 29 thus constitutes the predefined destination from which the setpoint values for the orientation and position of the trailer 22 can

be derived. The setpoint orientation and the setpoint position are expediently known and can be conveyed to the path computer 13 via the destination-inputting device 15. The combination vehicle 3 is located here at any desired point on the site 28, while the towing vehicle 21 and trailer 22 can have any desired orientations. The path computer 13 receives precise knowledge about the actual values of the orientation and position of the towing vehicle 21 and of the trailer 22 via the orientation- and position-determining device 14. The path computer 13 then calculates a movement path for the combination vehicle 3, whose movement vectors BV can be processed in particular automatically. It is clear here that the movement vectors BV of the drive assembly 4 of the drive train 2 are expediently actuated only in such a way that the combination vehicle 3 moves relatively slowly, in particular at walking pace. As is apparent from fig. 4, the movement path can contain a movement path section in which the combination vehicle 3 travels backward. In fig. 4, a movement path section 32 in which the combination vehicle 3 is traveling backward is illustrated by a broken line. The individual points 33 which are arranged along the movement path section 32 symbolize here the structure of the movement path which is composed of parts of the movement path which are arranged in series one next to the other.

Provided that the original position of the combination vehicle 3 is suitable for directly approaching the destination position for the trailer 22 in the holding bay 31, this can be readily implemented by automating the vehicle movement. The maneuvering and in particular the backward travel of the combination vehicle 3 can thus be carried out in a very efficient way. However, if the original position of the combination vehicle 3 is not suitable for directly driving into the destination position in the holding bay 31, the path

computer 13 can be configured, in one development, in such a way that before the backward travel the movement path generates an amount of forward travel 34 corresponding to the movement path section 32, and said forward travel 34 moves the combination vehicle 3 from an unfavorable original position into a favorable intermediate position from which the combination vehicle 3 can be moved directly by means of backward travel 32 in such a way that its trailer 22 moves with the desired orientation into the holding bay 31 as far as the loading ramp 29.

The sensor system 17 can be installed fixed to the vehicle and may comprise, for example, distance-measuring sensors. In the embodiment explained with reference to fig. 4, it may be expedient to provide sensors which are positionally fixed and which sense, for example, the approaching of the trailer 22 to the loading ramp 29.

The operator control device 10 can be connected via radio to the drive train interface 11 or to the path computer 13 so that the vehicle can be remote-controlled. On the other hand, the operator control device 10 can also be coupled directly to the path computer 13 via a transmission line for the transmission of signals.